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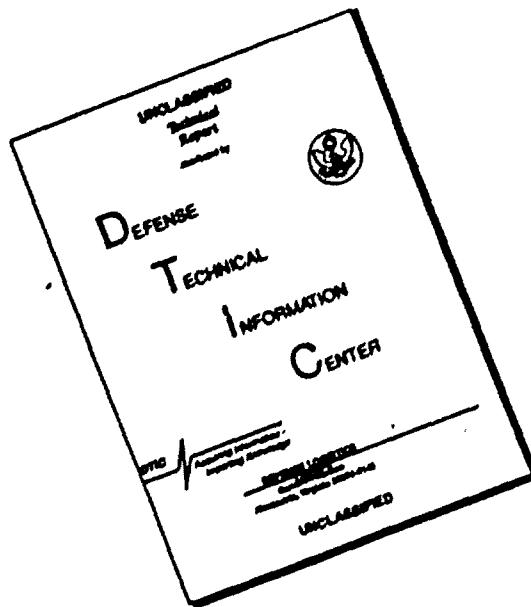
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# U. S. NAVAL AIR TEST FACILITY (SI)

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Report No. NATF(SI)-EI-115

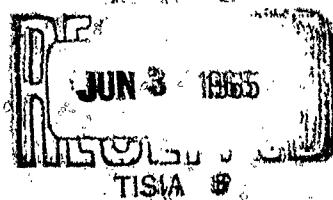
6 May 1965

## AIRFIELD TELEVISION CONTROL CENTER MOBILE UNIT EVALUATION

BUREAU OF NAVAL WEAPONS  
PROBLEM ASSIGNMENT NUMBER RSSH-99-059/204/8

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(SHIP INSTALLATIONS)  
U. S. NAVAL AIR STATION  
LAKEHURST, NEW JERSEY

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1. Introduction: Reference (a) directed Nael(SI) to develop a criteria for the evaluation of the Ampex Corporation Airfield Television Control Center (ATCC) Mobile Unit as applicable to the F-104G program and directed NATF(SI) to prepare an evaluation report. Reference (b) outlined Nael(SI) evaluation criteria. The ATCC mobile unit arrived at NATF(SI) on 30 November 1964. Installation was conducted by Ampex representatives with NATF(SI) engineering and technical assistance and was completed on 6 December 1964. Ampex turned the equipment over to NATF(SI) on 9 December 1964 and evaluation commenced this date. Ninety-seven F-104G aircraft launchings and 110 F-104G and A-4B aircraft arrests were monitored by the Ampex equipment.

2. Test Equipment and Procedure

a. This is a closed-circuit television system consisting of an observation camera, centerline camera, data camera, and a trailer for housing the necessary electronic equipment for the recording and playback of the television images. This system can be operated from a generator built into the equipment trailer or from shore power when available.

(1) One camera with extend/retract mirror assembly and variable glide-slope presentation capability is installed in a pit on the F-104G site runway centerline, 685 feet from the approach end of the matting. A special matting section is required for installation. The pit also contains equipment to heat or cool the camera to maintain proper operating temperature. A sump-pump installation is provided to keep the pit dry. Located to the left side of the runway and connected to the pit by two underground 6-inch pipes is a waterproof enclosure. This enclosure contains an air compressor for operating the pop-up mirror assembly and the centerline camera, ventilating fans for the camera pit, and circuit breakers for equipment in the waterproof enclosure and pit. (See Figures 1, 2, and 3.)

(2) One tripod-mounted observation camera with panning and zooming capabilities is mounted on the roof of the trailer located on the left side of the runway, 410 feet forward of the approach end of the matting: it can also be located up to 200 feet from the equipment trailer, whichever affords the optimum vantage point. The camera is equipped with a 400-millimeter zoom lens for use as a pan camera for overall aircraft coverage, and is connected by a video control cable to a camera control unit in the equipment trailer (see Figures 1, 4, and 5).

(3) A data camera, shown in Figure 6, is located in the equipment trailer and is used to record the information displayed on a data panel. This information may consist of aircraft speed (radar), time, date, and wind speed and direction.

(4) A mobile (trailer) control center (see Figures 1 and 4) contains the following equipment and facilities:

(a) Mobile power supply - Onan 25 KW gasoline-driven generator, Ford six-cylinder-drive engine; outputs: 208 volts three phase, and 115 volts single phase.

(b) Video-tape recording/playback system - Ampex Model VR-1100 (see Figure 7).

(c) Set-up and adjustment controls for both centerline and trailer-mounted cameras (see Figure 8).

(d) Briefing/debriefing monitoring area.

(5) Another major system component is an automatic infrared detector system for automatic retraction of the centerline-camera mirror assembly. One detector cell is located on each side of the matting at the approach end. The infrared detectors are located to sense the tail-pipe infrared radiations of a landing jet aircraft and will drop the mirror flush with the surface of the runway, before the aircraft passes over it, in the event the LSO and/or operator neglect to do so in time (see Figure 1).

(6) A retractable pop-up mirror projects above the surface of the runway when the centerline camera is in use. The mirror can be raised and lowered by the LSO or the operator in the equipment trailer. It can also be lowered by the above infrared detector system (see Figures 1, 9, and 10).

(7) A servo-controlled reticule for centerline and glide-slope alignment of the landing aircraft is superimposed on the image from the centerline camera. This reticule is controlled in the equipment trailer to set the desired glide-slope angle.

b. The following paragraphs describe the system's configuration and operating procedure:

(1) The output of each camera (centerline, observation, or data camera) is fed to a preview monitor and program switch panel located in the trailer control center. The operator in the trailer can switch any one of the cameras to the recorder's video line input to permit recording on magnetic tape. The data-camera output can also be fed into the split-screen special-effects generator. This enables the data-camera output to occupy the upper one-quarter of the television image, with the lower three-quarters of the screen reserved for the centerline or observation camera. This allows the data-camera output to be recorded simultaneously with the observation or centerline camera during aircraft operations. The LSO station monitor is also connected to the recorder's video-line input to allow the LSO to view the information being recorded when an

aircraft is landing on the runway. The centerline camera can supply the LSO with glide-slope information from the reticule system.

(2) The video magnetic-tape recorder can record any one of the three cameras at any one time or the split-screen mode (the data-camera output in conjunction with the output of either the centerline or the observation camera). One audio track can also be recorded. A second audio cue track for added commentary can be recorded at any time during or after an event. This cue track can be erased and re-recorded without affecting the other audio and video tracks previously recorded on the tape.

(3) The video-line output (playback) of the magnetic-tape recorder is fed to a conference monitor in the equipment trailer for pilot debriefing. This monitor can also be switched to any one of the television cameras or the video-line input to the magnetic-tape recorder for live viewing while the event is occurring as well as for the playback of recorded events. An audio monitor is also incorporated into the conference monitor for the audio and cue channels.

(4) Setup and maintenance of equipment is as follows:

(a) The manufacturer of the equipment has supplied manuals for the proper setup and maintenance of the equipment in the system. The equipment must be set up in accordance with these procedures, otherwise damage to the camera video tube (orthicon) or associated equipment may result. The setup of the video-tape recorder and the television cameras requires the use of a special monitor and oscilloscope which is built into the system.

(b) The television cameras and recording equipment must be turned on approximately one hour before use to allow the equipment to reach operating temperature.

### 3. Test-Analysis Procedure and Results

a. The following areas were considered in the evaluation of the ATCC mobile unit:

(1) Installation

(a) System's road and field mobility and ability to withstand transportation over rough terrain.

(b) Interference of any part of installed system with air and ground traffic.

- (c) Adequacy of weather protection for equipment and operating crew.
- (d) Adequacy of safety provisions for crew.
- (e) Adequacy of heating and air-conditioning systems.
- (f) Adequacy of space for efficient operation and maintenance.
- (g) Centerline-camera installation - watertight camera housing adequacy; resistance to impact, shock and vibration; size and weight in relation to ease of installation or maintenance.
- (h) Adequacy of matting rigidity in relation to ATCC components.

(2) Operation

- (a) Experience levels required of operating and maintenance personnel.
- (b) Calibration and alignment of centerline-camera reticule and stability of alignment during operations. Adequacy of centerline camera field-of-view and detail of presentation.
- (c) Reliability of centerline retract mirror.
- (d) Reliability of infrared detection system.
- (e) Adequacy of trailer generator and effect of excessive cable lengths.
- (f) Adequacy of equipment used to test and calibrate the system components.
- (g) Adequacy of spares provided.
- (h) Adequacy of audio and/or video recording and playback system performance.
- (i) Adequacy of preventive maintenance procedures.

(3) Miscellaneous

- (a) Merit of recording and playing back of aircraft operations.
- (b) Suitability of camera locations.

- (c) Reliability of system components.
- (d) Adequacy of debriefing monitors.
- (e) Adequacy of split-screen presentation.
- (f) LSO and pilot's comments.

b. The following test results were realized:

(1) Installation

(a) No specific tests were conducted relating to system mobility or ability to withstand transportation over rough terrain; however, most of the system was ground transported to NATF(SI) and then moved over crude dirt roads to its final installation area. No damage or difficulty was encountered and it is assumed that the system is as mobile and as able to withstand transportation over rough terrain as any commercial truck or cab and van combination of equivalent size and weight.

(b) Installation of system components in relation to the overall site is illustrated in Figure 1. Located as indicated, the system imposes no obstruction to ground or air traffic.

(c) Trailer overhead reinforcement is adequate to support the loads imposed by the observation camera, camera operator, and several assistants; however, weather protection and safety railings on the roof are not provided and are deemed necessary. Further safety considerations, presently lacking, include: a monopod rather than existing tripod support for the observation camera, to give the cameraman more freedom of movement during rapid panning actions; provisions for de-icing the roof working area; lack of restricting devices on the generator-access and two personnel-exit doors to prevent the wind from catching these and swinging them out of control; permanent securing of entrance stairways and platforms to the trailer; sufficient observation windows in the trailer should be located on both sides and in the forward end of the trailer.

(d) The size of the trailer and the arrangement of equipment allows adequate space for operation and maintenance if the number of operating personnel is limited to two at any one time. The debriefing-area size is satisfactory.

(e) Heating is adequate for personnel comfort and for equipment performance; however, the thermostat should be relocated further away from the exit door. Tests were conducted during the cold-weather portion of the year; therefore, the air-conditioning system could not be evaluated for hot-weather operations. Lighting is not adequate and should be improved for servicing equipment and reading manuals. In addition,

existing illumination is considered marginal for optimum performance of operating personnel during actual operations.

(f) In its present design, the two 6-inch pipes that connect the centerline pit liner and the waterproof enclosure must be placed in position prior to matting installation. Because the matting joint locations can not be exactly controlled, it is unlikely that the 6-inch pipes will line up with the holes in the pit liner as was the case at NATF(SI) (see Figure 11); therefore, some type of flexible joint is required. For this installation, NATF(SI) provided sheet-metal transition sections.

(g) The size of the pit liner prevented its installation by the removal of only one matting section--an adjacent row of matting had to be removed.

(h) The centerline pit installation is not adequately protected against flooding. The pit filled with water to within one foot of the runway surface during a heavy rainstorm (see Figure 12). A larger-capacity sump pump and outlet lines were provided by Ampex, but the program was concluded before this change could be properly evaluated. In addition, it is not possible to prevent dirt and condensation from entering the pit; consequently, the centerline camera must be removed once a week (a four- to six-hour operation) to clean the system optics. An accumulation of dirt or ice can prevent the mirror from being raised or lowered as required. The watertight seals on the centerline-camera case were damaged during initial installation, thereby making it impossible to properly pressurize the case. During a heavy rainstorm, four gallons of water entered the case. Evaluation of this component could not be conducted because the proper design configuration (a sealed, pressurized, waterproof housing) was never realized. Although structural tests were not performed, the pit assembly was analyzed as structurally adequate for withstanding the maximum impact and shock loads of the F-104G aircraft main wheels.

(i) The special matting section of the centerline pit installation is connected to surrounding matting. Matting vibration, induced by aircraft roll-over or personnel walking in the area, negates consistent calibration of the glide-slope reticule. More positive matting securing techniques (for example, earth anchors) probably would not alleviate this situation but should be checked.

(j) From a maintenance standpoint, the centerline camera and equipment is too large for the present-size pit. Further, a NATF(SI) field modification (see Figure 13) was necessary to enable accomplishment of camera installation and removal. Some metal was removed to allow the reticule lamp housing to pass through.

(2) Operation

(a) Operating and maintenance personnel training and experience requirements: cameramen - photographic motion-picture background; console operator/maintenance men - electrical, electronic background.

(b) The LSO and console operator each have a switch that controls the centerline camera mirror; the mirror is raised by pressing the switch to the ON position, and lowered by releasing pressure on the switch. Initially, as long as one of these switches was held ON, the other could not drop the mirror. This was modified so that the console operator controlled an additional "panic switch". Turning this switch OFF removes power from the system and drops the camera mirror regardless of whether either of the other two switches are ON. The infrared detector system was designed to automatically drop the mirror upon detecting the plane's exhaust; however, this system functioned improperly throughout the evaluation period. The infrared detector system provides an important function and is a required part of the ATCC system; however, the ultimate value of this component cannot be evaluated until its problems are corrected and proper operation is obtained. A positive contact switch, similar to that now in use by LSO's to activate the "cut-light" circuit of the optical landing aid, should be used in place of the present momentary-contact spring-return switches; a backlog of experience with the positive-contact switch will reduce the possibility of human error in operating the mirror drop.

(c) The centerline camera lens has an adequate vertical and horizontal field-of-view. Glide-slope calibration is easily achieved (see Appendix A), but the calibration can not be maintained because of the matting vibration problem noted in paragraph 3b(1)(i) that must be resolved. Aircraft detail during day operations is adequate; however, night operations were not, but should be conducted in order to completely evaluate the system. The system is not completely remote controlled: the refrigeration and air-compressor units must be turned on at the waterproof enclosure. These controls should be located in the trailer for convenient use by the console operator.

(d) Shore power available had to be increased from 114 to 117 volts because of line-voltage drop that was experienced whenever the heating or air-conditioning system went on. The initial line voltage drop of 4 volts interferred with the video signal. After the increase, the voltage drop was only 2 volts and did not adversely affect video output. Although the trailer generator can handle the current load, it is unsatisfactory from a frequency and voltage regulation standpoint because it can not compensate for surges (heating and air-conditioning units going on). The gasoline-engine governor is the only regulation provided, and this is unsatisfactory.

(e) No spares were provided with the subject installation. In a majority of instances where repairs were necessary, components were returned to Ampex or the Ampex representative had to make arrangements to have spare parts delivered to NATF(SI). The cameras are British built and require British parts; some of the tubes do not have American equivalents. Some test equipment was furnished and this was adequate to meet normal servicing requirements. Anything other than normal servicing was beyond the capability of NATF(SI) mainly because of the lack of spares, special-purpose tools and test equipment, technical information, and adequately trained personnel. The only established preventive maintenance procedure related to periodic maintenance of the tape transport.

(f) Video and audio recording/playback capability is adequate. LSO/pilot conversations should be recorded for post-operation study: such comments could prove of value when considering control problems related to recorded events.

(g) The ability of an aircraft nose gear to withstand impact with a raised mirror (a possible occurrence if mirror jams in the raised position) was not evaluated.

(3) Miscellaneous

(a) Existing camera locations are suitable; however, additional centerline cameras would improve monitoring of the total approach and touchdown of the F-104G aircraft. Generally, touchdown does not occur until after the present mirror assembly has been lowered. Also, automatic switching from the centerline to the observation camera would improve the coverage. This could be accomplished when the centerline mirror drops. It is now done manually by the console operator.

(b) The one briefing/debriefing monitor is adequate. Split-screen presentation is not crowded on the present size screen. The data camera (vidicon tube) burns its image on the tube target; if left on for more than one minute at a time, it will eventually ruin the tube.

(c) The present communication system (console to observation-camera operator) is not good. This is studio-type equipment that should be replaced with high-noise-level communications equipment. Further, there is no communication between LSO and trailer console operator.

(d) LSO and pilot comments: This equipment is excellent in two areas--that of LSO/pilot training and for overall coverage and immediate playback in cases of an accident or equipment malfunction. Glide-slope data may be of some benefit if reticule calibration could be made more accurate; however, the experienced LSO knows the required glide slope and probably achieves his optimum performance by watching the aircraft rather than the TV monitor.

4. Summary

a. The major problem area is the centerline-camera installation.

(1) The infrared detector system was never operative but should be a required functioning component of this system. Ampex worked on this problem during the entire evaluation period, but had not resolved the situation at the conclusion of the test period. During one arrestment, the centerline camera mirror (under manual control) was not lowered in time and the arresting hook caught the mirror; the resulting damage is shown in Figures 14 and 15.

(2) Matting vibration was a problem, but one which could be resolved possibly by redesign so as to separate camera installation from matting. The present arrangement does not permit accurate, consistent, or stable calibration of camera reticule, which in turn negates the possibility of precise glide-slope information.

(3) The pit sump-pump system was inadequate. The substitute, a larger-capacity pump and lines, may have resolved the pit flooding situation, but time did not permit complete evaluation of the new components furnished by Ampex.

(4) The centerline-camera support cradle was not adequately designed from a structural standpoint. Many of the welds cracked. An Ampex-furnished replacement cradle did not indicate any design changes or improvements.

(5) Centerline-camera optics require continual cleaning (once a week - 4 to 6 hours). This involves removing camera from pit, cleaning, and reinstalling in pit.

(6) The pit liner is too large to lower through the one special mat section.

5. Conclusions

a. The system presently has merit as an LSO/pilot training tool and for overall general coverage for recording of accidents and equipment malfunction.

b. Glide-slope information could prove helpful if accurate and precise data could be furnished. This will require redesign of system components.

c. Equipment could be made more useable as a piece of test equipment if slow speed, stop frame, and LSO/pilot recorded commentary capabilities were added.

- d. Component redesign is indicated for:
  - (1) Pit-liner size.
  - (2) Centerline-camera pit modification.
  - (3) Centerline-camera cradle modification.
- e. An improved spares situation is necessary.
- f. Maintenance, calibration, and operation of the equipment is considered beyond the capability of average military operating personnel.
- g. Detrimental nose/main gear impact loads are expected if a malfunction precluded lowering of the camera mirror assembly.

6. Recommendations

- a. Correct the infrared detector system so that it will function as it was meant to.
- b. Incorporate the following safety measures:
  - (1) Weather protection for personnel who must work on roof of the trailer.
  - (2) Safety railings on roof of trailer.
  - (3) Monopod support for observation camera.
  - (4) De-icing provisions for trailer roof.
  - (5) Permanent securing of entrance stairways and platforms.
  - (6) Generator and personnel exit-door restrictors.
  - (7) Windows in the trailer.
- c. Increase illumination in the trailer.
- d. Improve weather protection of the centerline-camera pit:
  - (1) Water exclusion and removal.
  - (2) Dirt and condensation influx.
- e. Isolate centerline-camera pit installation from matting.

- f. Reduce the size of the pit liner to fit through one special matting section.
- g. Reduce the size of the centerline-camera assembly so as to fit into a smaller pit liner and facilitate handling.
- h. Incorporate positive-contact-type switches for controlling centerline-camera retract. This type of switch is now used in visual optical landing aids (Fresnel Lens System) and operating personnel are accustomed to them. The positive response required for actuation also reduces possibility of human error.
- i. Incorporate remote controls in trailer for operation of centerline pit heating and air-conditioning equipment.
- j. Incorporate frequency and voltage regulation in the trailer generator system.
- k. Improve communication between console operator and observation cameraman and add LSO/trailer console operator communication capability.
- l. Incorporate slow speed, stop frame, simultaneous centerline/observation camera recording, and LSO/pilot recorded commentary capabilities.
- m. Improve structural design of centerline-camera cradle.
- n. Establish adequate spares commensurate with operational requirements.
- o. Simplify maintenance requirements, with operating personnel capability as prime consideration.

7. References

- (a) BUWEPS ltr RSSH-5/19:JTP of 7 Oct 1964
- (b) NAEL(SI) ltr NE-418:IB:hf 5400 of 4 Dec 1964

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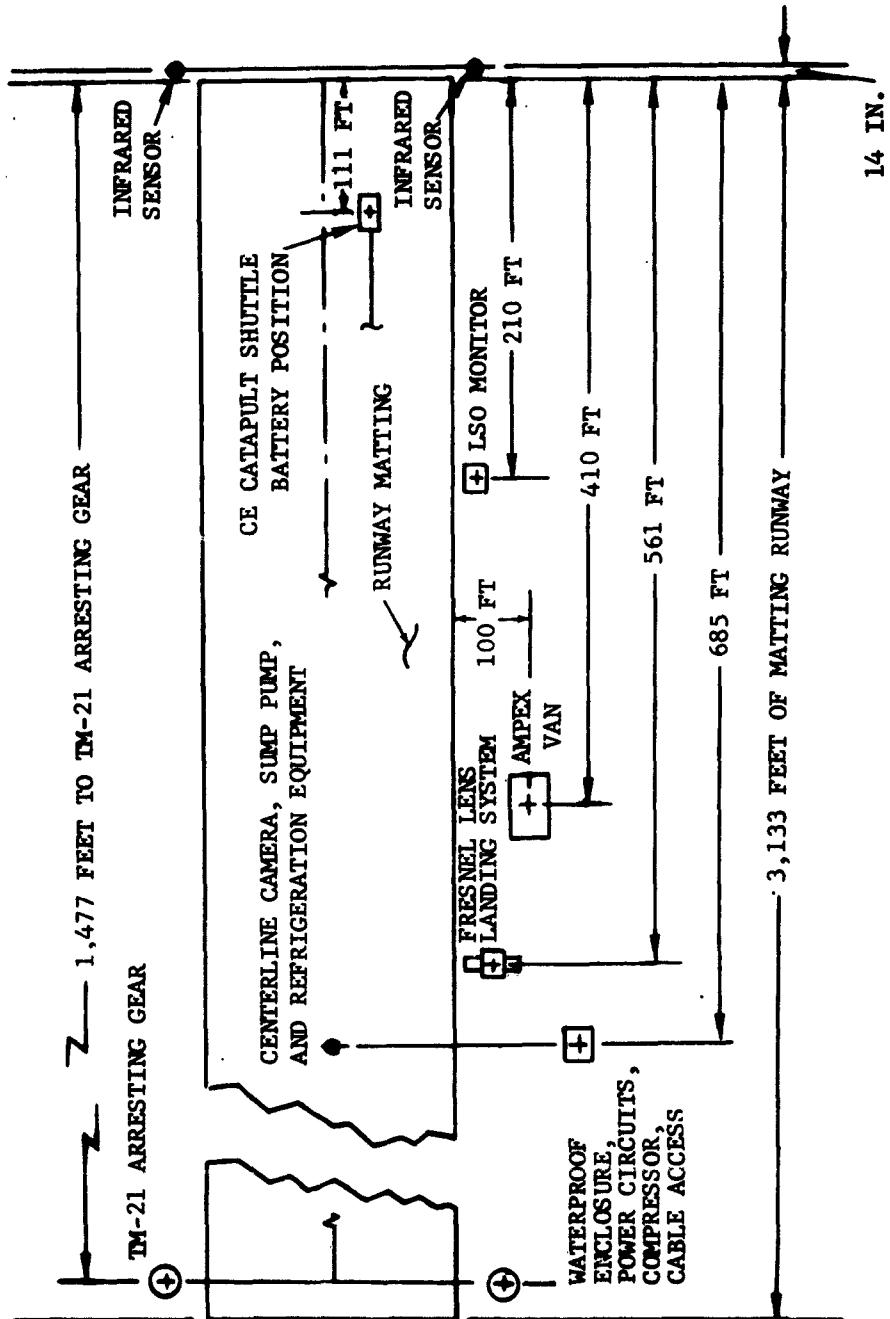


Figure 1 - Sketch Showing Layout of Airfield Television Control Center  
 Mobile Unit Equipment at NATF(SI) F-104G Site

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Figure 2 - Centerline Camera and Its Associated Equipment

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Figure 3 - Waterproof Enclosure

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Figure 4 - Airfield Television Control Center Trailer

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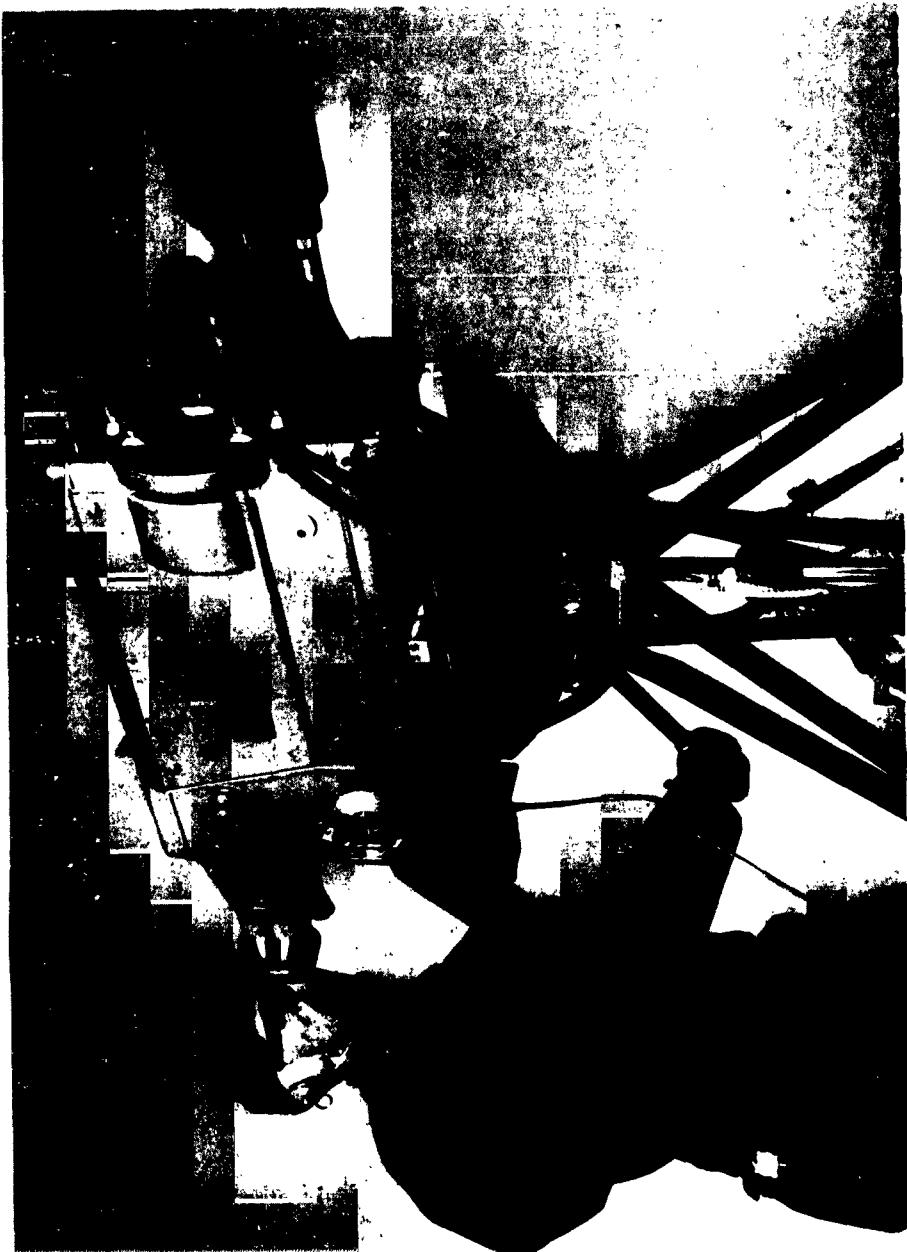


Figure 5 - Observation Camera Used With Airfield Television Control Center

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Figure 6 - Camera for Recording Event Data for Split-Screen  
Presentation in Conjunction With Either  
Observation or Centerline Camera

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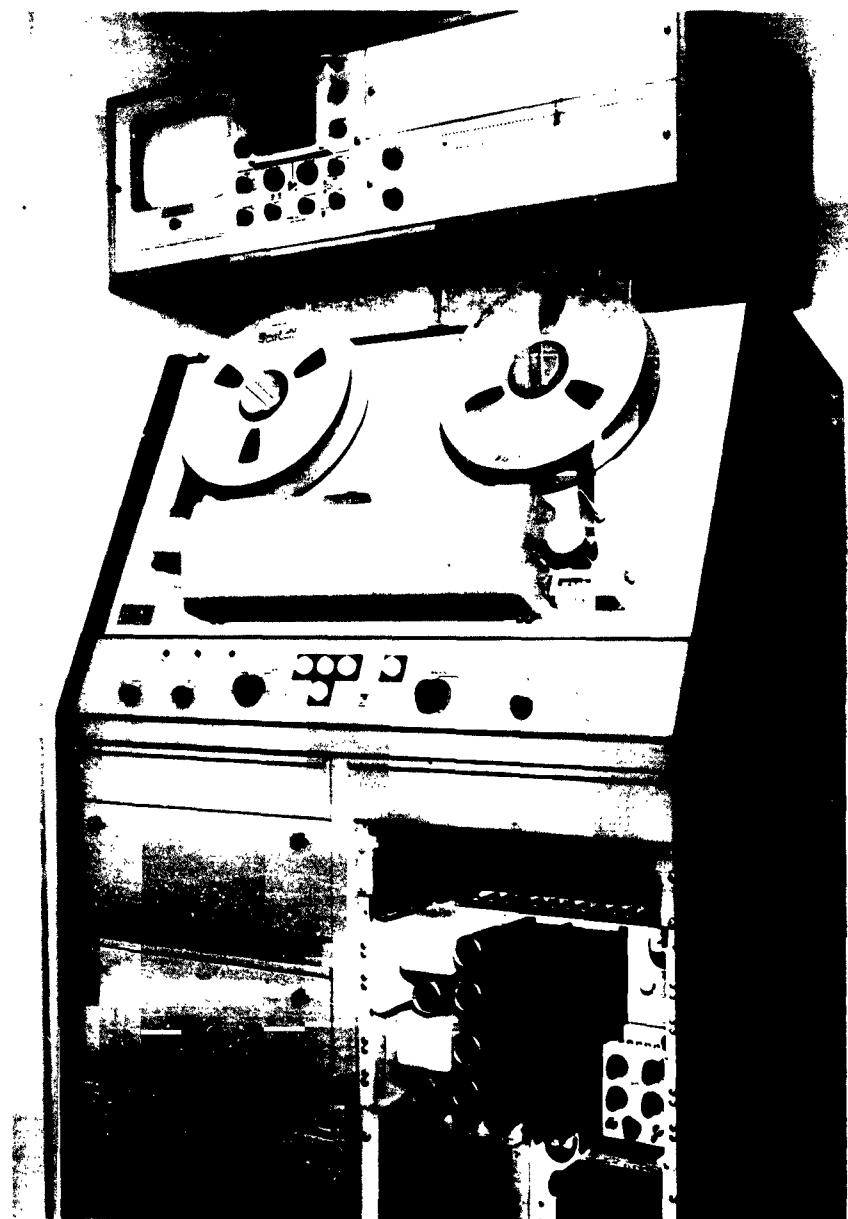


Figure 7 - Video-Tape Recording/Playback System

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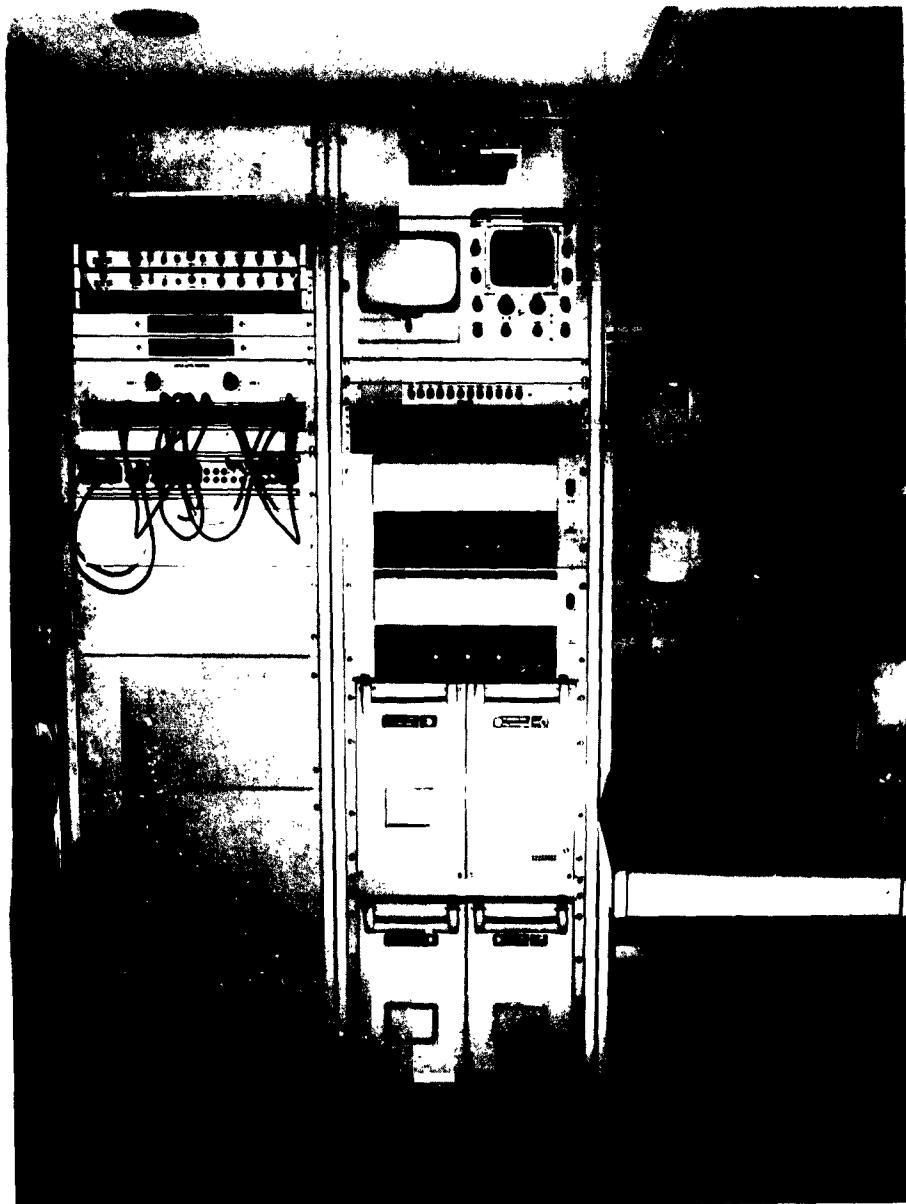


Figure 8 - Setup and Adjustment Controls for Both  
Centerline and Trailer-Mounted Cameras

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Figure 9 - Centerline Pop-Up Mirror - Raised Position

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Figure 10 - Centerline Pop-Up Mirror - Lowered Position

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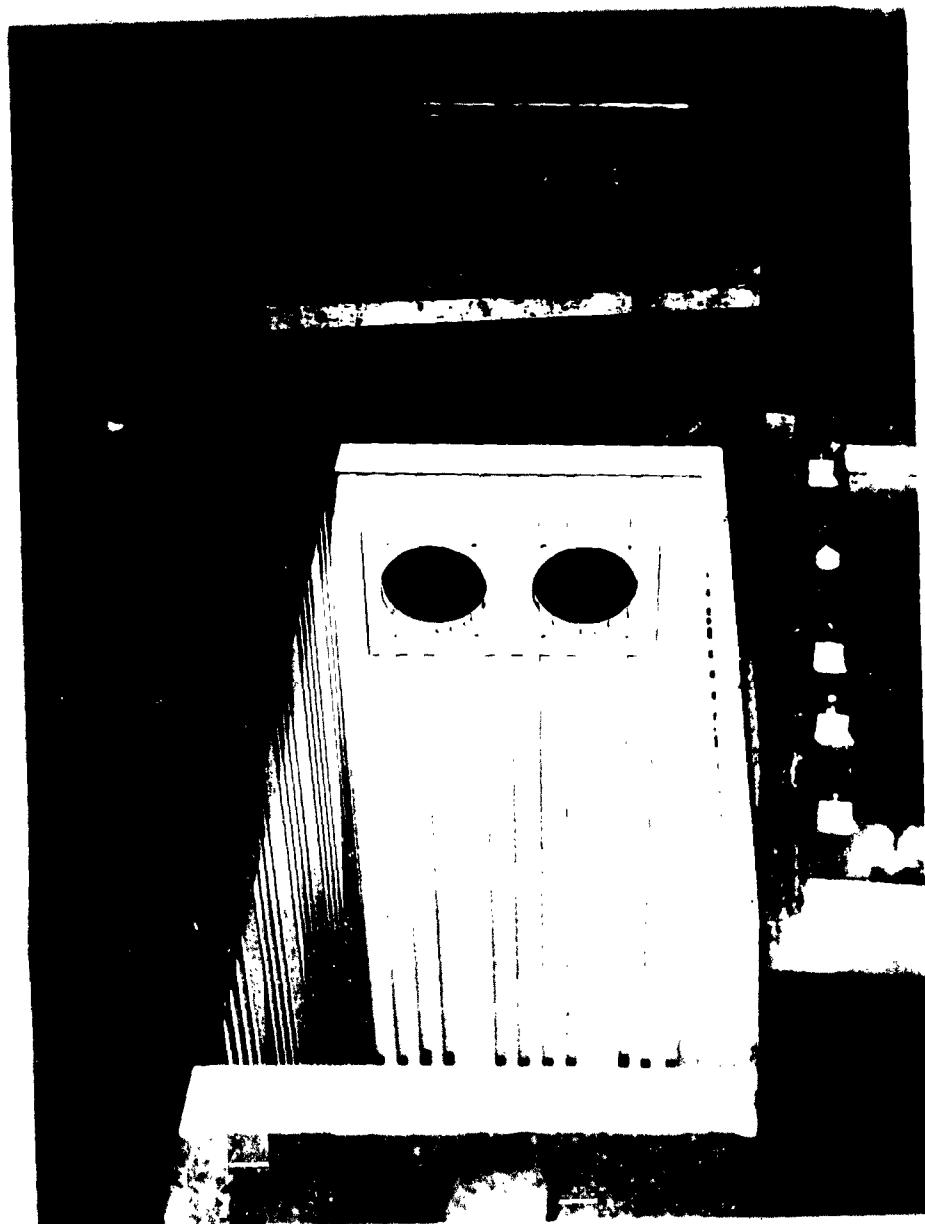


Figure 11 - Six-Inch Pipeline Leading to Centerline-Camera  
Pit Liner

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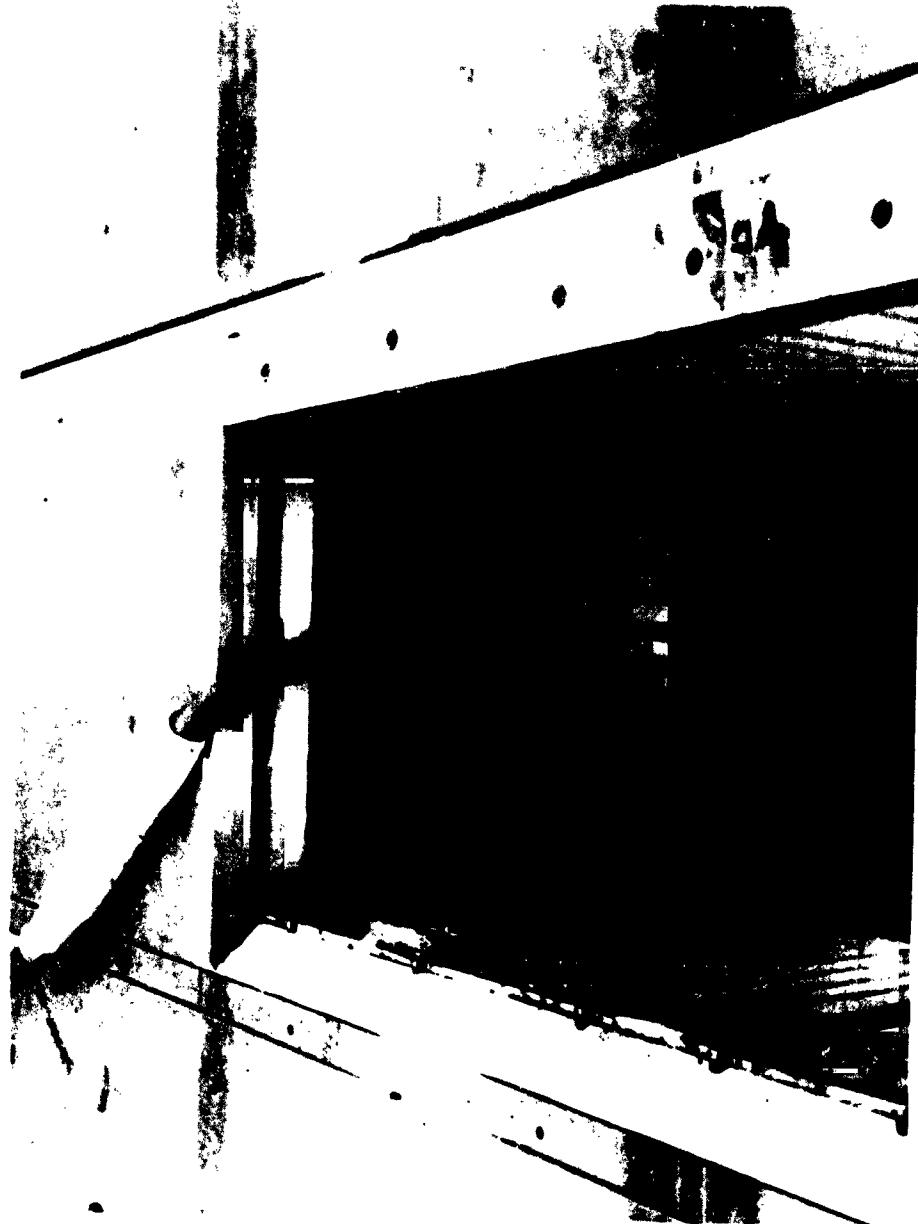


Figure 12 - Flooded Centerline-Camera Pit

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Figure 13 - NATF(SI) Modification to Centerline-Camera Pit -  
Required Before Camera Could be Installed

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Figure 14 - Pop-Up Mirror Assembly Damage

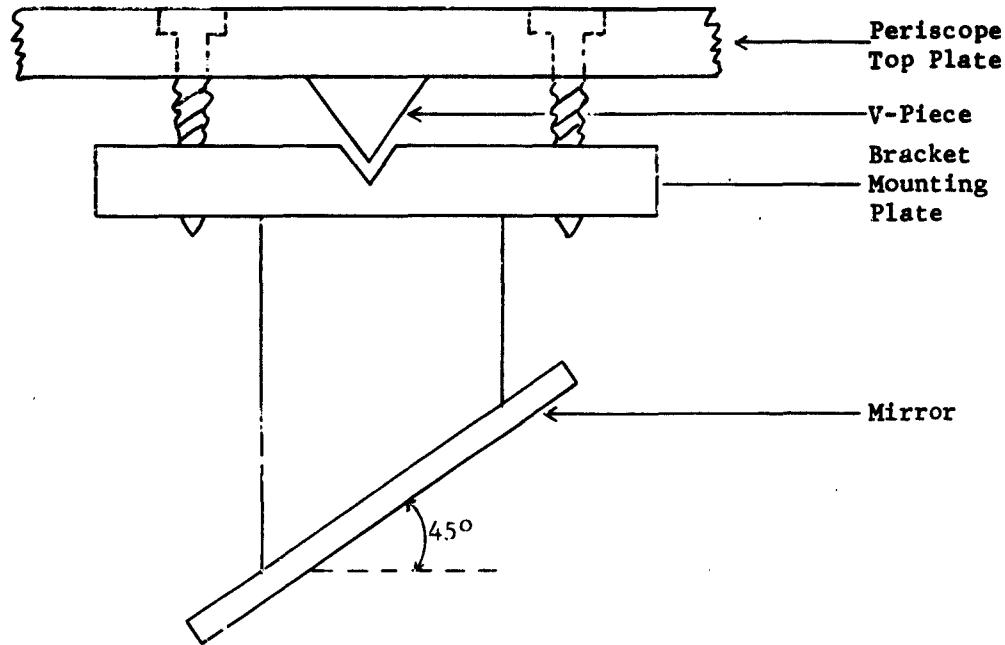
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(SHIP INSTALLATIONS)  
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Figure 15 - Pop-Up Mirror Cylinder Damage

APPENDIX A - AMPEX GLIDE-SLOPE CALIBRATION PROCEDURE



The mirror is attached to a  $45^{\circ}$  mounting plate, which is attached to the periscope top plate by a V-piece and four alignment screws.

1. The mirror is set in an initial position so that the bracket mounting plate is approximately parallel to the periscope top plate.
2. The periscope is raised to the UP position with the centerline camera on and warmed up.
3. The camera is monitored in the control trailer and the horizontal reticule is set to the  $1^{\circ}$  position as indicated in the appropriate preview monitor.
4. A pole on which a height of 5 feet, 3 inches is clearly indicated is set up exactly 300 feet from the centerline camera, toward the approach end of the matting strip and on the matting centerline. This pole is viewed by the centerline camera. The horizontal reticule is set with the  $1^{\circ}$  graduation lined up with the 5-foot, 3-inch height mark on the pole by adjusting the four alignment screws (see paragraph 5). The optics of the lens and the engraved lines of the reticule glass plate are

such that after the above calibration is set up for  $1^{\circ}$ , all other angles will be correct. Verify this by observing that the  $0^{\circ}$  line coincides with the matting landing edge as seen in the monitor after the  $1^{\circ}$  calibration has been set.

5. The four mirror alignment screws are adjusted a small amount at a time until the desired alignment is achieved. Coordination between the person viewing the trailer monitor and the one moving the mirror via the alignment screws is accomplished with the camera communication system. When the final result is reached, all four screws are securely tightened, equally in turn, until all are secure.

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13. ABSTRACT

Report presents results of evaluation of Ampex Corporation's Airfield Television Control Center Mobile Unit. This equipment was used to monitor F-104G aircraft launchings and F-104G and A-4B aircraft arrests from a SATS matting strip site. The system incorporates magnetic-tape recording and playback capability of video and audio information. There are three television cameras in the system: One manned television camera, mounted on the roof of the trailer, has panning and zooming capabilities; a second automatic camera is located in a pit on centerline of matting with an up-and-down mirror and glide-slope presentation capability; pertinent data recorded by a third camera, located in the trailer, can be superimposed simultaneously on the monitors with the output of either the manned camera or the automatic runway centerline camera. An infrared detector system is used to automatically lower the centerline camera mirror when infrared radiation from an aircraft's exhaust is detected. Raising and lowering the mirror can also be accomplished by either the LSO or television console operator.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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2. Video  
3. Audio  
4. Television - Airfield Cont Ctr  
Mobile Unit

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3. Audio	3. Audio	3. Audio
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6. Ampex Equipment		6. Ampex Equipment	
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